

Magnetic Materials

Magnetic materials are pervasive throughout our society. They are used in magnetic recording media and devices, in all motors and transformers, on credit cards, in numerous types of magnetic sensors, in magnetic resonance imaging (MRI) machines, in microwave communications, in magnetic separation, and in magnetic cooling. Magnetic materials include metals, ceramics and polymers at different size scales ranging from large castings to particulates, thin films, multilayers and nanocomposites.

In the present trend to make devices smaller, new magnetic materials are constantly being developed. One critical need for implementation of these materials is the development of the measurement science needed for their characterization. This is the focus of the Magnetic Materials Program. Proper measurements of key magnetic properties, determination of the fundamental science behind the magnetic behavior of these new materials, analyses of the durability and performance of magnetic devices and development of Standard Reference Materials are key elements of this program. Some information is only obtainable by the use of unique measurement tools at NIST like the neutron diffraction facilities at NCNR, or the magneto-optic indicator film apparatus for observation of magnetic domain motion. Of particular interest is understanding the magnetic behavior of low dimensional systems, in which one or more characteristic dimensions have been reduced to nanometer sizes.

Areas of present study include preparation, characterization, and modeling of multilayers and other low-dimensional systems for optimized giant magnetoresistance effect and magnetocaloric effect, and spintronic systems wherein spin dependent magnetic devices are integrated directly into semiconductor chips. Giant magnetostriction alloys, prepared using combinatorial methods, are similarly analyzed. Observation and micromagnetic modeling of magnetic domains play a key role in understanding magnetization statics and dynamics. Advanced magnetic measurements are developed for a wide range of materials including weld metal ferrite standards, and are applied to a wide range of magnetic phenomena including magnetic exchange bias, magnetic susceptibility of small samples at high frequencies, and magnetization time response to a change in magnetic field. Magnetic measurement standards are prepared and certified.

Nanotribology of magnetic hard disks addresses the issue of durability and performance of the magnetic storage technology. It provides measurement techniques on friction, stiction, and ways to lubricate the hard disks to enable higher and higher areal densities.

By experimentally addressing important issues in magnetism, by bringing together the industrial and scientific communities through the organization of workshops and conferences in the area, and by the development and preparation of appropriate standards, NIST acts to accelerate the utilization of advanced magnetic materials by the industrial sector, and to enable industry to take advantage of new discoveries and innovations. In addition, close linkage with the national storage industry consortium (NSIC) which consists of 38 companies and a score of universities allows industrial relevance and partnership. Additional collaborations with Xerox, General Motors, Hewlett Packard, IBM, Seagate, and Motorola Corporations, for example, enable NIST to leverage its activities with the much larger, but complementary, capabilities of other organizations.